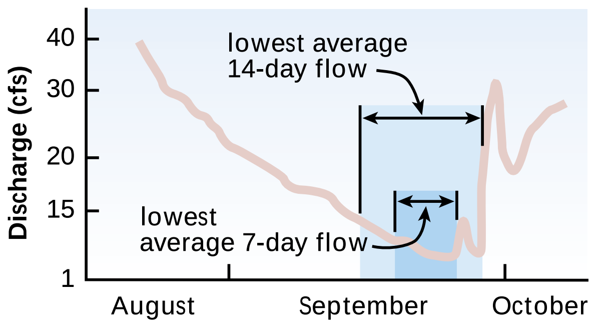

Figure 7.2: Annual hydrograph displaying low flows. *The daily mean flows on the lowest part of the annual hydrograph are averaged to give the 7-day and 14-day low flows for that year.*

USGS and USEPA recommend using the Pearson Type III distribution to the logarithms of annual minimum d-day low flows to obtain the flow with a nonexceedance probability p (or recurrence interval T = 1/p). The Pearson Type III low-flow estimates are computed from the following equation:

$$X_{d,T} = M_d + K_T S_d$$

where:

$X_{d,T}$ = the logarithm of the annual minimum d-day low flow for which the flow is not exceeded in 1 of T years or which has a probability of p = 1/T of not being exceeded in any given year

M_d = the mean of the logarithms of annual minimum d-day low flows

S_d = the standard deviation of the logarithms of the annual minimum d-day low flows

K_T = the Pearson Type III frequency factor

The desired quantile, $Q_{d,T}$, can be obtained by taking the antilogarithm of the equation.

The 7-day, 10-year low flow ($Q_{7,10}$) is used by about half of the regulatory agencies in the United States for managing water quality in receiving waters (USEPA 1986, Riggs et al. 1980). Low flows for other durations and frequencies are used in some states.

Computer software for performing low-flow analyses using a record of daily mean flows is documented by Hutchison (1975) and Lumb et al. (1990). An example of a low-flow frequency curve for the annual minimum 7-day low flow is given in **Figure 7.3** for Scott River near Fort Jones, California, for the same period (1951 to 1980) used in the flood frequency analyses above.

From Figure 7.3, one can determine that the $Q_{7,10}$ is about 20 cfs, which is comparable to the 99th percentile (daily mean flow exceeded 99 percent of the time) of the flow duration curve (Figure 7.1). This comparison is consistent with findings of Fennessey and Vogel (1990), who concluded that the $Q_{7,10}$ from 23 rivers in Massachusetts was approximately equal to the 99th flow duration percentile. The USGS routinely publishes low flow estimates at gauged sites (Zalants 1991, Telis 1991, Atkins and Pearman 1994).

Following are discussions of different ways to look at the flows that tend to form and maintain streams. Restorations that include alterations of flows or changes in the dimensions of the stream must include engineering analyses as described in Chapter 8.

Channel-forming Flow

The *channel-forming* or *dominant discharge* is a theoretical discharge that if constantly maintained in an alluvial stream over a long period of time would produce the same channel geometry that is produced by the long-term natural hydrograph. Channel-forming discharge is the most commonly used single independent variable that is found to govern channel shape and form. Using a channel-forming discharge to design channel geometry is